MICE RF TEST STAND

P.A. Corlett, A. Moss J. Orrett, CCLRC Daresbury Laboratory, Warrington, UK

Abstract

The Muon Ionisation Cooling Experiment (MICE) RF test stand is being assembled at Daresbury Laboratory. This will provide a test bed for power amplifiers to produce the 2MW 200MHz RF for the MICE experiment RF cavities. Initial design and proposed layout of the RF system are described.

INTRODUCTION

One of the greatest questions in physics is why there is more matter in the universe than antimatter (the C-P violation). This phenomenon could be explained with a greater knowledge of neutrinos. The standard model of particle physics predicts that neutrinos have zero mass, however experimental data has brought this assumption into question. If this is the case, C-P violation effects could be explained by neutrinos oscillating between three "flavours" - electron, muon and tau. In order to understand more about neutrino oscillations (and their role in C-P violations), a neutrino factory has been proposed to provide intense, collimated beams of neutrinos.

Neutrino Factory

In order to generate a beam of neutrinos, a proton beam is steered into a target (see Figure 1). This collision causes pions to be produced, which quickly decay into muons. These muons are then cooled, accelerated to their target energy and injected into a storage ring. The muons will then decay into neutrinos, and exit the storage ring in a collimated beam, towards a detector (which may be several hundred kilometres away).

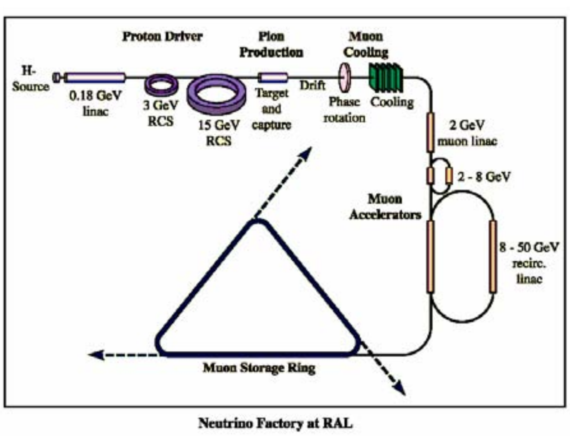

Figure 1: A typical Neutrino Factory schematic

MICE

One of the major technological obstacles to the construction of a neutrino factory is that the muon beam generated by the target has a large emittance. Ionisation cooling involves passing a beam through liquid hydrogen absorbers, this reduces the energy of the muons in all directions. RF cavities are then used to accelerate the beam in the longitudinal direction only. This results in a beam with significantly reduced emittance, and is estimated to improve the performance of a neutrino factory by a factor of 10. The purpose of the MICE project is to design, engineer, and build a section of cooling channel capable of providing the desired performance for a Neutrino Factory.

MICE RF Test Stand

The RF power sources for the MICE experiment [ref] are being provided by Daresbury Laboratory. The amplifiers being used to provide the MICE RF system have been donated by LBNL and require significant refurbishment. The constuction of new power supplies and ancilliary equipment is also required. The motivation to construct a test stand at Daresbury Laboratory is to provide the necessary infratructure to enable the refurbishment and testing of high power amplifiers prior to installation on the MICE experiment.

MICE RF POWER SYSTEM

The mice RF system (see Figure 2) is required to supply 1 MW of 200 MHz power to each cavity based on a pulse structure of 1 μs at 1 Hz Pulse Repetition Frequency (PRF).

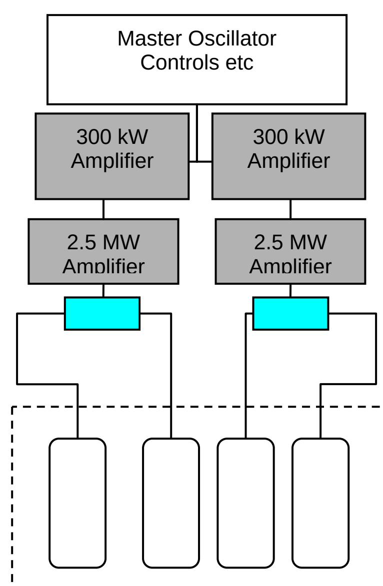

Figure 2: MICE RF system

Each RF power amplifier system is required to produce up to 2.5 MW which is then split using a 3 dB coaxial hybrid coupler, and fed into the RF cavities. To provide this power, the following amplification stages are used:

Low level Systems

- Master Oscillator
- The master oscillator consists of an Analog Devices DDS synthesiser.
- Low level RF system
- The phase and amplitude control system is based upon the FZR Rossendorf low level RF system (used on the ELBE machine), modified for use at 201MHz. This system provides extremely accurate control of phase (within 0.1º)
- Pre amplifier
- Initial amplification is provided by a solid state amplifier manufactured by Dressler. This increases the RF power from ~1 W to 4 kW.

Intermediate level

Intermediate amplification is provided by a Burle 4616 tetrode (see Figure 3), this raises the RF power from 4kW to 250kW. This amplifier system requires a HT power supply operating at 18 kV, and various ancillary systems. These systems are based upon the ISIS linac amplifier systems operated at Rutherford Appleton Laboratory.

Figure 3: Burle 4616 Tetrode

High power

The final amplification stage is provided by a Thales TH116 Triode (see Figure 4). This amplifier provides 2.5 MW of RF power necessary for MICE.

Figure 4: Thales TH116 Circuit

These amplifiers also require a HT power supply operating at 32 kV, and ancillary equipment. These systems are being designed and constructed by the power supply group at Daresbury Laboratory. The TH116 circuits require extensive refurbishment, having been unused for several years, and are in a general state of disrepair.

MICE RF TEST STAND

Proposed test stand layout

The RF test stand is being constructed in an empty plant room. The layout of the test stand is shown in Figure 5. This layout shows each stage of a complete MICE RF system providing 2.5 MW into a water load.

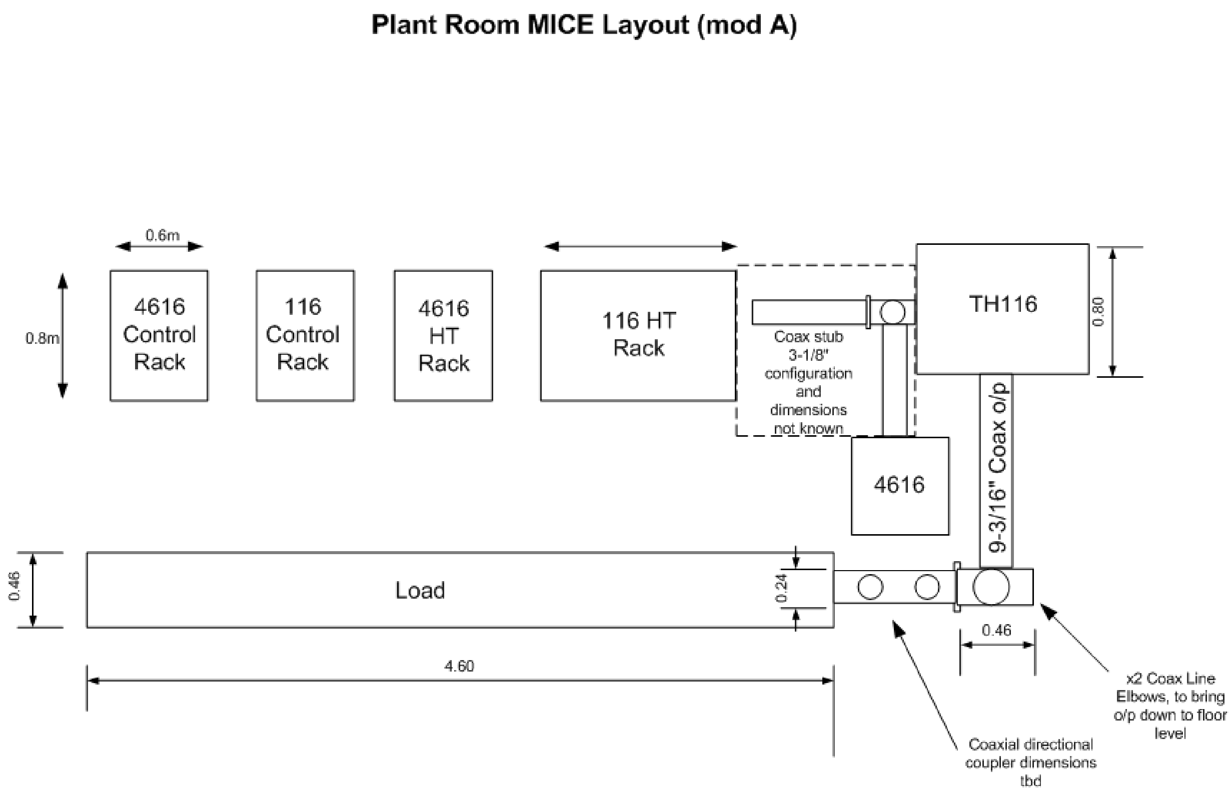

Figure 5: Proposed MICE RF test stand layout

Current progress

The status of the MICE RF test stand is as follows :

- The plant room has been cleared of all redundant and stored equipment.
- A cage has been erected to contain the RF test stand.
- Water services have been provided into the area, and a water distribution panel has been constructed
- Initial refurbishment work on the Burle 4616 circuits has been commenced.
- The Burle 4616 HT power supply and its ancillary rack are near completion.

SUMMARY / MILESTONES

Summary

The construction of an RF test stand for the MICE RF system is in progress at Daresbury Laboratory. This facility will be used to test the components of the MICE RF system prior to installation on the MICE beamline at Rutherford Appleton Laboratory.

Milestones

The following milestones have been set for the MICE RF system:

- First 4616 circuit operating - September 2006
- First 116 circuit operating - September 2007
- Transfer of equipment to MICE experimental Hall - 2008

REFERENCES

[1] A. Blondel, “An international muon ionisation cooling experiment”, August 2001.